WHAT IS CLAIMED IS:

1. A device for optically measuring qualities of a substance in ambient light comprising:

at least one translucent wall defining a sample chamber for receiving therein the substance to be measured and defining an axis;

at least one first radiation source mounted adjacent to the sample chamber, wherein the first radiation source emits a modulated beam of radiation distinguishable from the ambient light based on said modulation;

at least one first detector angularly spaced about the axis of the sample chamber relative to the first radiation source, wherein the first detector receives the modulated beam of radiation after passage through the sample chamber and substance to be measured therein, and generates a modulated output signal indicative of the intensity of the radiation of the beam impinging thereon;

a controller coupled to the first radiation source and the first detector for activating the source and processing the output signal; and

a display coupled to the controller for displaying measurement readings based on the output signals.

2. A device as recited in Claim 1, further comprising a housing defining a recess, and wherein the at least one translucent wall is formed by a vial defining the sample chamber therein, and the first radiation source and first detector are mounted adjacent to the recess.

3. A device as recited in Claim 1, wherein the at least one translucent wall is approximately cylindrical.

4. A device as recited in Claim 1, further comprising at least one oscillator coupled to the at least one first radiation source for modulating the source.

5. A device as recited in Claim 1, further comprising at least one amplifier coupled to the first detector for boosting the output signal and dampening other frequencies.

6. A device as recited in Claim 1, further comprising:

at least one second radiation source mounted adjacent to the sample chamber and angularly spaced about the axis of the chamber relative to the first radiation source, wherein the at least one second radiation source emits a second modulated beam of radiation distinguishable from the ambient light and the modulated beam of the first radiation source based on said modulation.

7. A device as recited in Claim 6, further comprising:

at least one second detector angularly spaced about the axis of the sample chamber relative to the second radiation source, wherein the second detector receives the modulated beam of radiation from the second radiation source after passage through the sample chamber and substance to be measured therein, and generates a second modulated output signal indicative of the intensity of the radiation of the beam impinging thereon.

8 A device as recited in Claim 7, further comprising an optical long-pass filter positioned in front of the second detector for separating a fluorescence emission intensity from scattered intensities of the at least one first radiation source and for reducing stray light.

9. A device as recited in Claim 1, further comprising a plurality of first radiation sources, each first radiation source emitting a principle ray wherein the principle rays extend through the axis onto a central region of the first detector.

10. A device as recited in Claim 1, wherein the at least one first radiation source is a light emitting diode.

11. An instrument for measuring characteristics of a substance comprising:

(a) a sample chamber for receiving therein a sample of the substance and defining an axis;

(b) a signal generator including at least one radiation source mounted adjacent to the sample chamber for emitting a beam of radiation through the sample chamber, and at least one detector angularly spaced about the axis of the sample chamber relative to the radiation source, wherein the detector receives the beam of radiation after passage through the sample chamber and substance to be measured therein, and generates an output signal indicative of the intensity of the radiation of the beam impinging thereon;

(c) a memory operatively coupled to the signal generator for storing data including a plurality of reference measurements based upon a plurality of different reference samples, wherein each reference sample has a different concentration of an impurity; and

(d) a controller in communication with the memory, wherein the controller is operative to:

(i) receive a signal from the signal generator based upon a sample within the sample chamber having an unknown concentration of an impurity;

(ii) automatically compare the signal to at least a portion of the reference measurements to determine a concentration of the impurity in the sample; and

(iii) generate an output signal indicative of the concentration.

12. An instrument as recited in Claim 11, further comprising a vial defining therein the sample chamber and a recess for removably receiving therein the vial.

13. An instrument as recited in Claim 11, wherein the sample chamber is defined by a conduit allowing a field sample to flow therethrough, the impurity is dissolved in the free-flowing substance, and the controller is further operative to monitor the concentration of the impurity.

14. An instrument as recited in Claim 11, further comprising a display for receiving the output signal and generating a human readable version of the output signal.

15. An instrument as recited in Claim 11, wherein the signal generator is modulated at a given frequency, and the signal is thereby modulated to distinguish the signal from ambient light and other signals modulated at different frequencies.

16. An instrument as recited in Claim 11, further comprising at least two signal generators, each defining a separate channel and meridional plane angularly spaced apart about the axis relative to each other.

17. An instrument as recited in Claim 11, wherein the controller performs the comparison by selecting first and second data points within the plurality of reference measurements, the first and second data points are above and below the signal, respectively, and the controller mathematically interpolates the data points to arrive at the output signal.

18. A device for analyzing radiant transmission and scattering of an elongated sample, wherein the elongated sample defines an axis, the device comprising:

a first channel defining a first meridional plane having the axis extending therethrough and including thereon at least one first radiation source mounted adjacent to the sample for emitting a first beam of radiation through the sample, and at least one first sensor angularly spaced about the axis of the sample relative to the first radiation source for generating a first output signal indicative of the intensity of radiation impinging thereon;

a second channel defining a second meridional plane having the axis extending therethrough and including thereon at least one second radiation source mounted adjacent to the sample for emitting a second beam of radiation through the sample, and at least one second sensor angularly spaced about the axis of the sample relative to the second radiation source for generating a second output signal indicative of the intensity of radiation impinging thereon; and

electronics for activating each of the channels and processing signals generated thereby.

19. A device as recited in Claim 18, wherein the at least one first radiation source includes a plurality of light emitting diodes axially spaced relative to each other, and wherein each light emitting diode is positioned so that a principle ray emitting therefrom substantially passes through the axis of the sample and onto the first sensor.

20. A device as recited in Claim 18, wherein the first and second radiation sources are selected from the group including green, red, yellow, orange, blue and near-infrared light emitting diodes.

21. A device as recited in Claim 18, wherein the first and second channels are angularly spaced approximately 45° apart.

22. A device as recited in Claim 18, further comprising a third channel defining a third meridional plane extending through the axis and including thereon at least one third radiation source mounted adjacent to the sample for emitting a third beam of radiation

through the sample, and at least one third sensor angularly spaced about the axis of the sample relative to the third radiation source for generating a third output signal indicative of the intensity of radiation impinging thereon.

23. A device as recited in Claim 18, wherein the second and third channels are angularly spaced approximately 45° apart and the first and third channels are angularly spaced approximately 90° apart.

24. A device as recited in Claim 18, further comprising a fourth channel defining a fourth meridional plane extending through the axis and including thereon at least one fourth radiation source mounted adjacent to the sample for emitting a fourth beam of radiation through the sample, and at least one fourth sensor angularly spaced about the axis of the sample relative to the fourth radiation source for generating a fourth output signal indicative of the intensity of radiation impinging thereon.

25. A device as recited in Claim 18, wherein the first and fourth channels are angularly spaced approximately 22.5° apart.

26. A device as recited in Claim 18, wherein the axis lies within the first meridional plane.

27. A device as recited in Claim 26, wherein the axis lies within the second meridional plane.

28. An instrument for testing characteristics of a material comprising:

a translucent cell for receiving a sample of the material; and

a housing defining an aperture for receiving therein the translucent cell, the housing including:

a first light source mounted within the housing adjacent to the aperture for emitting light at a first modulated frequency through the translucent cell placed in the aperture;

at least one detector mounted within the housing and spaced angularly relative to the first light source adjacent to the aperture for converting the modulated light of the first light source into an electrical signal after the modulated light of the first light source passes through the translucent cell, wherein the electrical signal is modulated at the first modulated frequency; and

a display for converting an output of the first detector into a human readable form.

29. An instrument as recited in Claim 28, further comprising:

a second light source for emitting light at a second modulated frequency through the translucent cell, wherein the at least one detector converts the light of the second light source into a second electrical signal at the second frequency after the light of the second light source passes through the translucent cell, the display converts an output of the detector into a human readable form, and the first and second modulated frequencies are different.

30. An instrument as recited in Claim 29, comprising the first and second light sources and corresponding detectors fixed along different channels.

31. An instrument as recited in Claim 28, wherein the first light source is a light emitting diode.

32. An instrument as recited in Claim 28, further comprising a controller for automatically comparing the first electrical signal which is indicative of a degree of transmittance to a database of stored values in order to determine a concentration of an impurity based on such comparing.

33. An instrument as recited in Claim 28, wherein the translucent cell includes a cap removably attachable for sealing the sample within the cell.

34. An instrument as recited in Claim 28, wherein the translucent cell is a conduit for receiving the material therethrough.

35. An instrument as recited in Claim 28, further comprising a beam-splitter positioned in front of the light source for directing a portion of the light to a reference detector and for indicating an output power of the light source to thereby monitor performance of the light source.

5

36. An instrument as recited in Claim 28, further comprising an amplifier operatively associated with the detector for boosting the electrical signal.

37. An instrument as recited in Claim 28, further comprising an oscillator operatively associated with the light source for modulating the light of the light source at the first modulated frequency.

38. An instrument as recited in Claim 28, further comprising a reagent contained within the translucent cell for mixing with the material and creating particles which scatter the light.

39. An instrument as recited in Claim 28, further comprising a reagent contained within the translucent cell for mixing with the material and creating fluorescence.

40. An instrument as recited in Claim 28, further comprising a reagent contained within the translucent cell for mixing with the material and creating an optical absorption band which reduces a transmissivity of the material.

41. An instrument as recited in Claim 28, further comprising a controller operatively coupled to the light source and detector, and wherein the translucent cell includes an electrical circuit mounted thereon and operatively associated with the controller to provide instructions for testing a material.

42. An instrument as recited in claim 28, wherein the translucent cell includes a cap attachable thereto for sealing the sample within the cell.

43. A device for optically measuring qualities of a substance in ambient light comprising:

first means defining a sample chamber for receiving therein the substance to be measured and defining an axis;

second means mounted adjacent to the sample chamber for emitting a modulated beam of radiation distinguishable from the ambient light based on said modulation;

third means angularly spaced about the axis of the sample chamber relative to the second means for receiving the modulated beam of radiation after passage through the sample chamber and substance to be measured therein, and for generating a modulated output signal indicative of the intensity of the radiation of the beam impinging thereon;

fourth means coupled to the second and third means for activating the second means and processing the output signal; and

fifth means for displaying measurement readings based on the output signals.

44. An instrument as recited in Claim 43, wherein the second means is a radiation source.

45. An instrument as recited in Claim 44, wherein the radiation source is a light emitting diode and an oscillator connected thereto.

46. An instrument as recited in Claim 43, wherein the third means is a sensor.

47. An instrument as recited in Claim 43, wherein the fourth means is a microprocessor and memory operatively connected to the second and third means.

48. A method for optically measuring qualities of a substance in ambient light comprising the steps of:

providing a sample chamber defining an axis for receiving therein the substance to be measured;

providing at least two radiation sources mounted adjacent to the sample chamber;

emitting modulated beams of radiation from the radiation sources, each source being modulated at a different frequency and, therefore, distinguishable from the ambient light and each other based on said modulation;

providing at least one first detector angularly spacing about the axis of the sample chamber relative to the first radiation source;

receiving the modulated beam of radiation by the first detector after passage through the sample chamber and substance to be measured therein;

generating a modulated output signal indicative of the intensity of the radiation of the modulated beam impinging on the first detector;

activating by a controller the first radiation source and the first detector;

processing the modulated output signal; and

providing a display for providing measurement readings based on the modulated output signal.

49. A method according to Claim 48, wherein any angle effects are automatically taken into account by storing a data point based upon a calibration with a pure water sample.

50. A method according to Claim 49, further comprising the step of dampening any signal at the frequency of ambient light.

51. An instrument for determining a concentration of an impurity within a sample, comprising:

(a) a housing defining a recess for receiving the sample;

(b) a source operatively connected to the housing for emitting optical energy through the sample;

(c) a detector operatively associated with the housing for receiving the optical energy and converting the optical energy into a data point for the sample;

(d) at least one memory operatively associated with the housing, the at least one memory configured for storing a database of calibration readings for a plurality of concentrations of the impurity; and

(e) at least one processor in communication with the at least one memory, wherein the at least one processor is configured for determining the concentration of the impurity based upon comparing the data point for the sample to the database of calibration readings.

52. An instrument as recited in Claim 51, wherein the source is a light emitting diode.

53. An instrument as recited in Claim 51, wherein the detector is a photovoltaic detector.

54. An instrument as recited in Claim 51, further comprising:

at least one oscillator within the housing and operatively connected to the source;

a power cell within the housing for driving the at least one oscillator; and

a vial for receiving the sample, the vial defining a centerline axis;

a second source operatively connected to the housing for emitting optical energy through the sample;

a second detector operatively associated with the housing for receiving optical energy, wherein the light sources and detectors lie on fixed axes and meridional planes passing through an axis of the sample.

55. An instrument as recited in Claim 54, further comprising a base mounted on the vial, the base having a printed circuit board, wherein the printed circuit board has memory for providing data to the processor.

56. An instrument for measuring characteristics of a substance comprising:

(a) first means for defining a sample chamber for receiving therein a sample of the substance and defining an axis;

(b) second means mounted adjacent to the sample chamber for emitting a beam of radiation through the sample chamber and generating an output signal indicative of the intensity of the beam of radiation after passage through the sample;

(c) third means operatively coupled to the second means for storing data including a plurality of reference measurements based upon a plurality of different reference samples, wherein each reference sample has a different concentration of an impurity; and

(d) fourth means in communication with the second and third means, for:

(i) receiving a signal from the second means based upon a sample within the first means having an unknown concentration of an impurity;

(ii) comparing the signal to at least a portion of the reference measurements to determine a concentration of the impurity in the sample; and

(iii) generating an output signal indicative of the concentration.

57. An instrument as recited in Claim 56, wherein the first means is a vial.

58. An instrument as recited in Claim 56, wherein the second means is a light emitting diode and a photovoltaic detector.

59. An instrument as recited in Claim 56, wherein the third means is random access memory and read only memory.

60. An instrument as recited in Claim 56, wherein the fourth means is a microprocessor and a software program stored on the third means.

61. An instrument for analyzing color and scattering of an sample, wherein the sample defines an axis, the instrument comprising:

first means for defining a first meridional plane and including thereon second means for emitting a beam of radiation modulated at a frequency, the second means mounted adjacent to the sample for emitting said beam of radiation through the sample, and third means for sensing angularly spaced about the axis of the sample relative to the second means, the third means generating a first output signal indicative of the intensity of radiation impinging thereon;

fourth means for defining a second meridional plane and including thereon fifth means for emitting a beam of radiation modulated at a second frequency, the fifth means mounted adjacent to the sample for emitting said beam of radiation through the sample, and sixth means for sensing angularly spaced about the axis of the sample relative to the fifth means for generating a second output signal indicative of the intensity of radiation impinging thereon; and

seventh means for activating the first and fourth means and processing said output signals generated thereby.

62. An instrument as recited in Claim 61, wherein the seventh means activates the second and fifth means simultaneously and corresponding signals generated thereby are distinguishable.